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Fundamental understanding on the use of different carbon sources in the alternative ironmaking HIsarna process

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Abstract

HIsarna process offers a low CO_2 emission alternative to the blast furnace for hot metal production. This new smelting ironmaking technology is flexible in raw materials such as substitution of coal with biomass. The reduction process is conducted through multiple mechanisms within the smelting reduction vessel (SRV) including reactions of the gaseous products from thermal decomposition of carbonaceous materials with iron oxide in slags. Since the construction of the HIsarna pilot plant (at the capacity of 8t hot metal/hour) in Tata Steel site in the Netherlands in 2010, several successful trial campaigns have been completed using thermal coals. Campaigns to partially replace coal with biomass and charge steel scraps in the SRV were also successfully conducted since 2018 demonstrating further significant CO_2 emission reduction, however, the change in process performance due to biomass injection was noticed.

To advance the fundamental understanding of the use of different carbonaceous materials in the HIsarna process and help optimise the carbonaceous material selection, a systematic research has been carried out for different carbon sources under simulated HIsarna thermal conditions. The thermodynamic and kinetic behaviours of the carbon-gas-slag-metal systems have been studied for coal and biomass injection in laboratory experiments. This talk will introduce some research findings from this systematic research, including slow/rapid devolatilisation of the carbon sources injected, structural characteristics of the resultant chars, and slag-carbon reactions for coals and biomass.